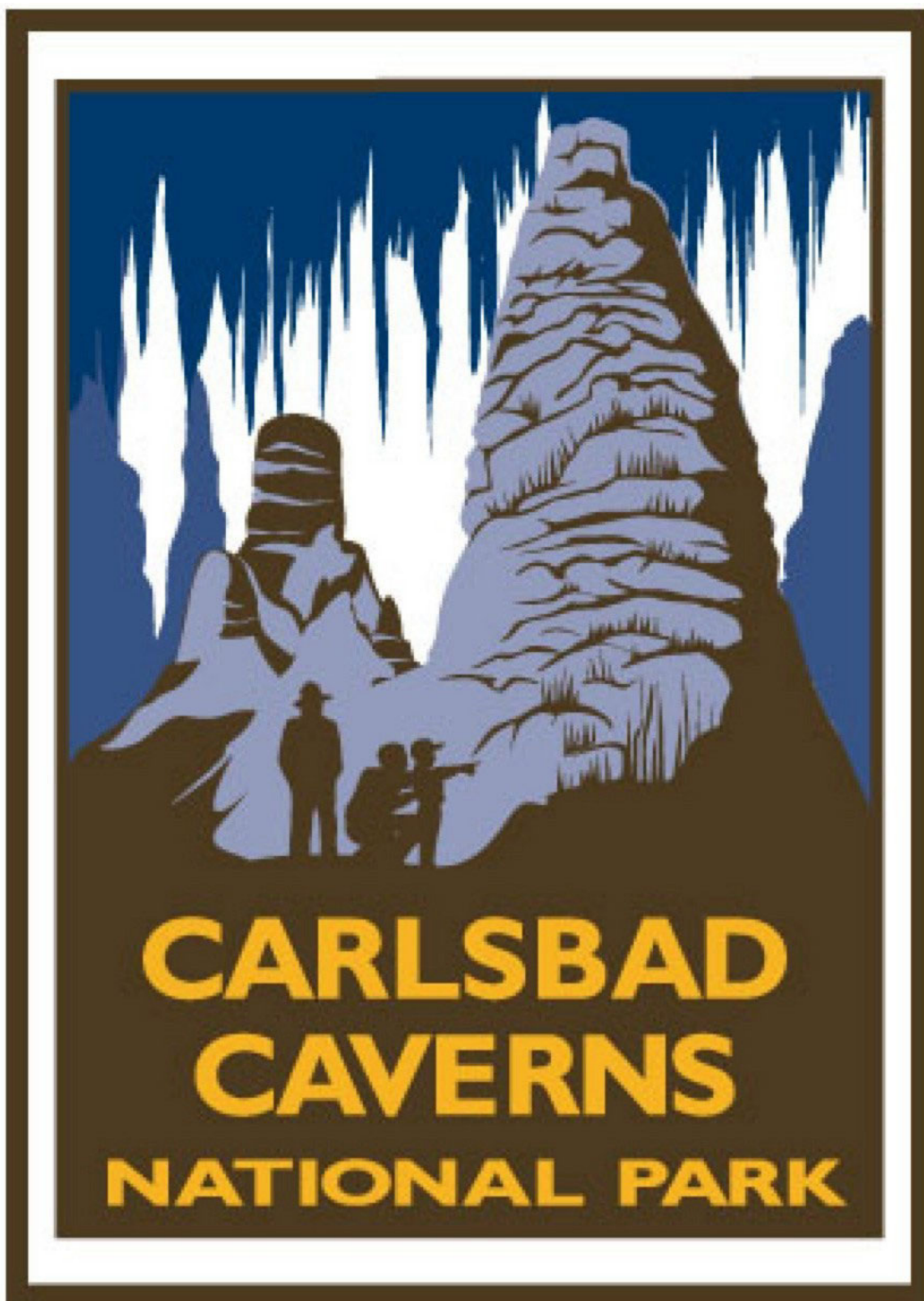


# Life Science

A curriculum and activity guide for Carlsbad Caverns National Park



## *Middle School Ecology*



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# Water

People that live in the desert need to be extra careful with water usage. We only have a limited supply of fresh water to drink and use. That is why it is important that we use water wisely and protect our water supplies whenever and wherever possible. If we each save a small amount of water each day, our combined savings will add up to millions of gallons each year. Unlike traditional desert people, most of us tend to take water for granted. We turn on the tap and it is always there. We wallow in hot baths, take long showers, and water our lawns to an unnatural perfection. We are probably the most profligate users of water in the world; yet it is estimated that between a third and a half of all that water is wasted. Only 1% of the water on Earth is usable for humans. Much of this surface water and useable underground water is polluted or contaminated. Water pollution is a very serious problem. There are two major sources of pollution. One is point source pollution. This form of pollution enters the waterways from a pipe or some other clear point of discharge. An example is a sewer pipe that empties into a river. The other is non-point source pollution. This form of pollution enters waterways from various sources, none of which can be identified. Examples of this type of pollution include: fertilizers, pesticides, detergents, and other chemicals that run off into our local rivers, creeks, ponds, and groundwater. Most of the pollution in the cave pools at Carlsbad Caverns National Park is directly related to non-point source pollution. The cave pools have trace amounts of antifreeze, motor oil, and other chemicals that have run off the parking lot and have slowly worked their way to the pools through leaching.

This unit will focus on water availability, water consumption, and water quality. In the first activity, *All the Water in the World*, students will visualize and understand the percentage of the Earth's water that is safe for drinking. In the second activity, *How Much Water Do You Use?*, students will identify how much water they use and find ways to conserve this valuable resource. In the third activity, *What's in There?*, students will develop an understanding of water pollution and its potential effects on wildlife and human habitats. In the fourth activity, *Sediment as a Pollutant*, students will understand how sediment gets into bodies of water and its effects on life. The final activity, *Water Pollution*, explores the effects of detergents and fertilizers on aquatic life.



# All the Water in the World!

*How much fresh drinking water is there?*

**Summary:** This lesson is designed to help students understand that there is only a small fraction of usable drinking water on Earth and that this valuable resource must be protected.

**Duration:** 1 week

**Setting:** Classroom/Lab

**Vocabulary:** karst, groundwater, water cycle

**Standards/Benchmarks Addressed:** SC1-E1, SC1-E2, SC2-E1, SC2-E2, SC2-E3, SC3-E1, SC4-E1, SC4-E3, SC4-E4, SC4-E5, SC5-E2, SC6-E1, SC6-E2, SC6-E3, SC6-E4, SC6-E5, SC6-E6, SC9-E2, SC11-E6, SC12-E1, SC12-E2, SC12-E3, SC12-E7, SC16-E1, SC16-E2, SC16-E3

## Objectives

Students will:

- recognize that there is a lot of water in the world but only a small fraction can be used for drinking water and other water supply needs.
- recognize that groundwater is a very small percentage of the Earth's water.
- understand how important it is that we take care of our ground water.

## Background

From looking at maps and satellite photographs we know that about  $\frac{3}{4}$ <sup>th</sup> of the Earth's surface is covered in water. 97% of the water on the Earth's surface is salty (unusable) ocean water while the remaining 3% is fresh water. Most of that fresh water (2% is frozen in the ice caps and glaciers where it is unavailable for human use. Only 1% of all water is found in lakes, rivers, and underground aquifers.

The area surrounding Carlsbad Caverns National Park is characterized by karst landforms. Karst landforms are produced through the dissolving of rocks such as limestone, dolomite, marble, gypsum, and salt. Features of a karst landscape include caves, sinkholes, large springs, dry valleys, and sinking streams. These landscapes are characterized by sufficient flow of groundwater through conduits in dissolved rock. In these areas water quickly drains to the subsurface at zones of recharge and a network of fractures, partings, and caves and returns to the surface in zones of discharge at springs, seeps, and wells.

The source of all groundwater is precipitation. When rain falls, plants and soil absorb some of the rainwater, some of it drains into streams, some evaporates, and the remainder moves downward recharging aquifers. Groundwater moves through the water cycle as part of a dynamic system from recharge areas (caves, sinks, fractures, and partings) to areas of discharge that flow into streams, lakes, wetlands, or the ocean. Streams that flow during periods of little rainfall are fed or produced by a groundwater system.

Knowing the fact that there is such a limited supply of fresh water we need to conserve and protect as much of it as possible.

## Materials

5 gallons of water

5-gallon aquarium  
Measuring cup (24 ounce)  
Blue food coloring  
Ice tray  
Dropper  
6-ounce see through container  
Sand

### Procedure

**Warm up:** Have five gallons of water in an aquarium. Tell students that this represents all the water in the world. Have the students predict the percentage this water represents:

Ocean:.....	97.2%
Groundwater:.....	0.397%
Surface water:.....	0.022%
Ice Caps/Glaciers:.....	2.38%
Atmosphere:.....	0.001%

Have students write their predictions in a journal.

### Activity

1. Remind the students that the five gallons represent all the water in the world. Remove 18 ounces of the water from the aquarium with the measuring cup. Using the blue food coloring, color the remaining water in the aquarium. Tell the student that the water in the aquarium represents all the water on Earth that is held in the oceans. The water in the measuring cup represents all the water that is not ocean.
2. Pour 15 ounces of the water from the measuring cup into the ice tray. This water represents the water held in glaciers and ice caps. (This water is not readily available for use.)
3. The remaining 3 ounces represent the world's available fresh water. Of this amount, only a fraction of an ounce is held in the world's fresh water lakes and rivers. Place this water (only one dropper of water) into a student's hand.
4. The remaining 2.5 ounces of water is ground water. Pour this remaining water into a cup of sand and explain that this is what is referred to as groundwater. This is water that is held in pore spaces of soil and fractures in the bedrock.
5. Discuss what the students learned from the lesson and discuss the actual percentages of water resources.

**Wrap Up:** Ask these follow-up questions:

- Why isn't all fresh water usable? *(Some is not easy to get to; it may be frozen or trapped in unyielding soils or bedrock fractures. Some water is too polluted to use.)*
- Why do we need to take care of the surface/ground water? *(Water is very important for humans, plants/crops, and animals. If we waste water or pollute it, we may find that there is less and less of it available for us to use.)*

Students will:

- Research karst areas and describe what they are and how they are related to groundwater aquifers. Research should include sinks, caves, recharge areas, and discharge areas. Students must also include reasons for and ways of protecting/conserving our ground water. With the research students should include a correctly labeled picture of the water cycle, including what is happening under ground. A

wonderful example of this can be found in the book: Living With Karst: A fragile Foundation. To order contact: AGI at [www.agiweg.org](http://www.agiweg.org) or (703)379-2480.

**Assessment**

See rubric for grading criteria.

**Extension**

Have students create a graphic organizer showing the 5 sources of Earth's water (oceans, ground water, surface water, ice caps/glaciers, and atmosphere). Have them list the ways they are used and ways they are polluted.

## All the Water in the World

Karst Research	Self evaluation	Teacher evaluation	Comments
<b>Visual criteria:</b>		<b>/12</b>	
Includes a detailed labeled picture of above ground activity			
Includes a detailed labeled picture of underground activity			
Includes a short summary of what is happening in the visual			
<b>Research criteria:</b>		<b>/16</b>	
Includes a description of karst areas and how they relate to groundwater aquifers			
Includes recharge and discharge areas and examples of each			
Includes reasons for protecting/conserving groundwater			
Includes ways of protecting/conserving groundwater			
<b>Overall:</b>		<b>/12</b>	
Has the student fulfilled all the parts of the task?			
Has the student used proper grammar and sentence structure?			
Has the student cited appropriate resources?			

4 no mistakes    3 few mistakes    2 many mistakes    1 incomplete (however is present)    0 not evident or not included

Percentages: Visual \_\_\_\_\_    Research \_\_\_\_\_    Overall \_\_\_\_\_



# How Much Water Do You Use?

*How much water does your family use in one week?*

**Summary:** This lesson is designed to help students identify ways water is used and their family's water usage and have them find ways to reduce water consumption.

**Duration:** 1 week

**Setting:** Classroom/home

**Vocabulary:** conservation

**Standards/Benchmarks Addressed:** SC2-E1, SC2-E2, SC4-E4, SC4-E5, SC5-E2, SC6-E1, SC6-E2, SC6-E3, SC6-E4, SC6-E6, SC11-E6, SC11-E8, SC12-E2, SC14-E2, SC15-E2, SC16-E1, SC16-E2, SC16-E3

## Objectives

Students will:

- Identify ways in which water is used.
- Analyze a family's water use with a focus on ways to reduce water consumption.

## Background

From looking at maps and satellite photographs we know that about  $\frac{3}{4}$ <sup>th</sup> of the Earth's surface is covered in water. 97% of the water on the Earth's surface is salty (unusable) ocean water while the remaining 3% is fresh water. Most of that fresh water (2%) is frozen in the ice caps and glaciers where it is unavailable for human use. Only 1% of all the water is found in lakes, rivers, and underground aquifers.

People that live in the desert need to be extra careful with water usage. We only have a limited supply of fresh water to drink and use. That is why it is important that we use water wisely and protect our water supplies whenever and wherever possible. If we each save a small amount of water each day, our combined savings will add up to millions of gallons each year.

Unlike traditional desert people, most of us tend to take water for granted. We turn on the tap and it is always there. We wallow in hot baths, take long showers, and water our lawns to an unnatural perfection. We are probably the most profligate users of water in the world; yet it is estimated that between a third and a half of all that water is wasted.

## Water Conservation Tips

**Bathroom:** Two-thirds of the water used in the average home is used in the bathroom, mostly for flushing toilets, showering, and bathing.

1. Turn off water when you are not using it. Don't let the water run while you brush your teeth or shave.
2. Flush your toilet less often. Put used tissues, trash, hair, and paper towels, in the wastebasket instead of flushing them.
3. Fix leaks and drips.
4. Change old plumbing fixtures with new flow reducing devices.
5. Take shorter showers, less than 5 minutes.

6. Take baths. If you like to linger in the shower change to baths, a partially filled tub uses less water than a shower.

### ***Kitchen and Laundry:***

1. Use appliances efficiently. Run full loads in the dish or clothes washer.
2. Buy a water saver. Select new appliances that are designed to minimize water usage.
3. Clean vegetables and fruit efficiently. Use a vegetable brush to speed up the cleaning process.
4. Use garbage disposals as little as possible. Start a compost pile or give your leftovers to your pet.
5. Keep a bottle of drinking water in the refrigerator. Avoid running the tap to get cool water for drinking.

### ***Lawn and Garden:***

1. Water the lawn and garden only when necessary. Early mornings and evenings are the best times. Let grass grow higher in dry weather. Avoid watering driveways and sidewalks.
2. Deep soak your lawn. Allow the moisture to soak deep down to the roots where it does the most good. A light sprinkle evaporates quickly.
3. Plant drought-resistant trees and plants.
4. Wash your car sensibly. Clean the car with a pail of soapy water and use the hose only for a quick rinse.

## **Materials**

Water usage worksheet

## **Procedure**

**Warm up:** Have students predict how much water their family uses in one week. Have them write their predictions on a piece of paper.

## **Activity**

1. Hand out a copy of the water usage worksheet. Students will be conducting the survey at home for a full week. Explain how to fill out the survey by making tally marks each time the activity takes place. After the surveys have been completed discuss the results.
2. Create a Venn diagram comparing the weekdays and the weekends.
3. Have students look at their water usage worksheets and consider what their family could do to reduce the amount of water they use. Make a list of possibilities. How much water would that conserve?

**Wrap Up:** Discuss water conservation tips. Look over the lists prepared by the students to see how they compare to each other. Students complete the follow-up questions.

## **Assessment**

Venn diagram, participation

## **Extension**

- Students write an article for the school newspaper describing ways people can conserve water.

- Students can write a brief newsletter for their parents reporting the results of the study. Honor the families that used the least amount of water. Include water conservation tips.
- Students conduct a survey of water conservation devices in their homes.

# Water Usage Worksheet

Name: \_\_\_\_\_

**Directions:** This data sheet will help you figure out how much water your family uses in one week. Place a tally mark in the day column every time someone in your family does the activity.

Activity	Times per Day							Weekly Total	Water per Activity	Total water used
	S	M	T	W	Th	F	S			
Toilet Flushing									X 5 gallons	
Short Shower (5-10 min)									X 25 gallons	
Long Shower (> 10 min)									X 35 gallons	
Tub Bath									X 35 gallons	
Brushing Teeth (water on)									X 10 gallons	
Brushing Teeth (water off)									X ½ gallon	
Dishwasher									X 16 gallons	
Hand washing dishes, filling the basin									X 10 gallons	
Washing machine									X 60 gallons (per load)	
Outdoor watering									X 10 gallons (per/min)	
GRAND TOTAL										

Using the information obtained through this survey, find the average use per person in your family. To do this, divide the total by the number of people in your family. The average is:

\_\_\_\_\_.

# Water Usage Follow-Up Questions

Name: \_\_\_\_\_

Use the information you obtained on the water usage worksheet to help answer the following questions:

1. In your home, which activity happened most often?

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2. Which activities use the most water each time they occur?

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3. What other activities at home consume large amounts of water?

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4. What things can your family do to conserve water?

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# What's In There?

*How clean is the water that you are drinking?*

**Summary:** This lesson is designed to help students understand that clear water is not always clean water and allows them to use water quality testing practices to test their own drinking water.

**Duration:** 2-4 class periods

**Setting:** Lab

**Vocabulary:** limnology, physical parameters, chemical parameters, biological parameters, pH

**Standards/Benchmarks Addressed:** SC1-E2, SC2-E1, SC2-E2, SC3-E1, SC4-E1, SC4-E3, SC4-E4, SC4-E5, SC5-E1, SC5-E2, SC6-E1, SC6-E2, SC6-E3, SC6-E4, SC6-E5, SC6-E6, SC6-E7, SC7-E2, SC7-E3, SC9-E3, SC11-E6, SC11-E8, SC11-E9, SC11-E10, SC12-E2, SC12-E3, SC14-E3, SC15-E2, SC16-E1, SC16-E2, SC16-E3

## Objectives

Students will:

- understand that some water pollutants cannot be seen.
- practice the techniques used by water quality examiners in their area.

## Background

Surface water is easy to see; it is the water that flows in our rivers, lakes, streams, bays, and oceans. However there is another important source of water that we often forget about. Groundwater is hidden from view; it is the water that fills the caves and aquifers underground.

Approximately half of the people living in the U.S. rely on groundwater for their drinking water. It is also one of the important sources for irrigation of crops. Unfortunately some groundwater in every state has become contaminated with pollutants. Some scientists fear that the percentage of groundwater contamination will increase as toxic chemicals dumped on the ground slowly make their way down to the underground water supplies of caves and aquifers.

Pesticides and fertilizers are some of the pollutants that seep into the groundwater. Others may include road salt, toxic substances from mining sites, and used motor oils. Untreated waste may also leak into the groundwater supply from faulty septic tanks and sewage leaks. This process of pollutants seeping down into the groundwater supply is very evident at Carlsbad Caverns. As scientists test the water in the cave pools they often find evidence of antifreeze, motor oils, and other pollutants that have worked their way down from the parking lot above the cave. Unlike surface water, contaminated groundwater is very difficult or even impossible to clean.

Our drinking water comes from a variety of sources and quality. Some of the water comes from water purification plants. Some comes from underground sources. Due to this diversity of these sources, the drinking water of you and your friends can differ greatly in quality and healthiness. The study of water is limnology. This involves physical, chemical, and biological conditions. Physical parameters (conditions) refer to water temperature, stream velocity, and clarity. Chemical parameters refer to the chemical makeup of water such as the amount of dissolved oxygen, phosphate, and nitrate. Biological parameters refer to the organisms supported in the water such as bacteria, plankton, and fish.

**Materials**

Glass jars (five for introductory exercise)  
Cotton balls  
Sugar  
Salt  
White vinegar  
Citric acid  
Tap water  
Goggles (one for each student)  
Rubber gloves (one pair for each student)  
Phosphate test kit and directions  
Coliform test kit and directions  
PH paper  
Data sheets  
Alcohol (for hand cleaning)  
Microscopes  
Five glass jars per group  
Water from a variety of source (bottled water, river, pond, irrigation ditch, well water, city tap water from different areas of town, etc.)  
Microscope

**Prep**

Teacher must prepare the jars with the 5 clear liquids. Record what each jar contains and have the activity set up before class starts.

Have the students bring in a milk carton of their drinking water. The teacher will also need to bring in a carton of water from a river, pond, irrigation ditch, well water, or water from any other source they have available.

**Procedure**

**Warm up:** To help the students understand that clear water isn't necessarily free of pollutants, place 5 clear liquids in glass jars. Use sugar water, white vinegar, salt water, water mixed with citric acid, and tap water. Using cotton balls, have the students taste each liquid (dispose of each cotton ball after each taste) and record what they taste after each. After all students have had a chance to taste, discuss that some kinds of pollution cannot be seen. Tell the students that they will be doing a variety of tests on water looking for different types of pollution.

**Activity**

1. Go over the directions for the phosphate coliform test kits and pH paper. Remind students that they are to wear goggles at all times while working with chemicals and unknown sources of water. They must also wash their hands after any contact with unknown water sources.
2. Divide students into groups of 2 to 3. Each student should have his/her own sample of five water types (bottled water, tap water, etc.) to begin testing. They will test each sample for:
  - a. odor
  - b. clarity/color
  - c. phosphates
  - d. pH
  - e. fecal coliforms

- f. observe through a microscope for bacterial forms.
- 3. Results should be recorded on the data sheet.
- 4. Go over the results of the tests with the students orally and explain what each test might indicate.
  - a. Bad odor- could indicate sewage pollution or algae. A chlorine odor could indicate treatment from a sewage treatment plant.
  - b. Clarity/color- poor clarity could indicate dissolved solids, like silt or soil in the water.
  - c. Phosphates- if phosphates are present it could indicate fertilizers, wastewater (detergents, sewage, etc.), and industrial discharge. These lead to algae blooms and plant blooms that consume CO<sub>2</sub> and kill everything in the water.
  - d. pH (acidity)- most biological systems have a pH at about 7.1. A low pH (acidic, below 5) or high (alkaline, above 9) may kill eggs, larvae, nymphs, hatchlings, etc. as well as leach toxic heavy metals from soils and rocks.
  - e. Fecal coliforms – these are bacteria derived from human feces, mainly E. coli. See directions in the kit for levels. High levels indicate contamination, possibly sewage being too close to the water supply.
  - f. Microscopic observation – some bacteria are normal and harmless. But it is interesting to see what kinds of critters are in the water we drink.

**Wrap Up:** Have students summarize what they learned from the lab, why we did the lab and how they can use the information from this lab again. Be sure they complete the data sheets.

### **Assessment**

Teacher observation, summary, data sheets

### **Extensions**

Have a Park Ranger from Carlsbad Caverns National Park come in and discuss water testing in the cave pools and how they clean up pollution in these pools.

Have a water quality expert from the city come in and discuss water-testing procedures used to monitor the drinking water in the city water wells and aquifers. They should also discuss the methods they use to conserve and clean up any unwanted materials in the city's drinking water.

\*For: Phosphate test kit, Coliform test kit, and pH paper contact:

Carolina Biological Supply Co.  
2700 York Road  
Burlington, NC 27215  
1-800-334-5551

## What's In There? Data Sheet

Name: \_\_\_\_\_

Please follow the phosphate and coliform test kit directions very carefully. Follow all lab safety procedures. Be sure to wash your hands after contact with unknown water sources.

Sample	Water type	Odor	Clarity/color	Phosphates	pH	Fecal coliforms	Bacterial forms
A							
B							
C							
D							
E							

Summarize what you learned from this lab.

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How can you use this information again?

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## **Sediment as A Pollutant**

### ***How does sediment affect water quality?***

**Summary:** This lesson is designed to demonstrate the effects of erosion and sedimentation and their effects on water quality.

**Duration:** 1 class period

**Setting:** Lab

**Vocabulary:** sediment, erosion, deposition

**Standards/Benchmarks Addressed:** SC1-E1, SC1-E2, SC2-E1, SC2-E2, SC2-E3, SC3-E1, SC4-E1, SC4-E3, SC4-E5, SC5-E1, SC5-E2, SC6-E1, SC6-E2, SC6-E3, SC6-E4, SC6-E5, SC6-E6, SC6-E7, SC8-E3, SC9-E1, SC11-E2, SC11-E3, SC12-E1, SC12-E2, SC12-E3, SC12-E7, SC14-E2, SC15-E2, SC16-E1, SC16-E2, SC16-E3

### **Objectives**

Students will:

- explain what sediment is and how it enters lakes and reservoirs.
- describe the effects of sediment on aquatic plant and animal life found in lakes.
- develop a method of protecting lakes from sediment deposits.

### **Background**

Weathering changes solid rock into small pieces of rock and soil. Much of the rocks and soils are carried away by agents of erosion, which are wind, ice, and moving water. Rock and soil that are carried away is called sediment.

Erosion is the picking up and moving away of weathered rock and soil. Water, wind, and ice that carry away weathered material are called agents of erosion. When an agent of erosion slows down, it drops, or deposits, its load of sediment. The dropping of sediment by these agents is called deposition.

Water is one of the most important agents of erosion. Moving water picks up and moves sediment. In a stream or river sand and smaller sediments are carried in the water. During a flood, water overflows the banks of a stream or river. It covers the land on both sides picking up sediment from that land. As the floodwaters decrease they bring deposits of sediment back into the river.

When rainwater runs off land that has been disturbed by human activity it picks up soil and silt and carries them to surface water. Once in the water, sediment can keep sunlight from reaching aquatic plants, clog the gills of fish, and can smother bottom dwelling organisms.

### **Materials**

Small aquarium

Soil

Pebbles

Watering can

Water

Metal tray

**Procedure**

**Warm up:** Ask the students what they think sediment is. Where does it come from? How does it get into our water supply? How do you think it affects the plant and animal life in our lakes and rivers?

**Activity**

1. Divide the class into groups of 2-4. Each group will be given a complete set of the materials listed above.
2. Students follow these directions to complete the exercise:
  - a. Fill a metal tray with loose soil and pebbles.
  - b. Tilt the tray slightly at one end. Place the metal tray on the edge of a filled aquarium.
  - c. Pour water over the soil using a watering can.
  - d. Observe the sediment deposits falling into the aquarium.
  - e. Repeat this procedure several times and record observations.

**Wrap Up:** Students will answer the follow-up questions.

**Assessment**

Participation

**Extensions**

Visit a river or lake to observe sediment deposits.

# Sediment Follow-up Questions

Name: \_\_\_\_\_

1. What is sediment?

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2. How did the rain affect the soil in the metal tray?

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3. What happened to the sediment carried by the rainwater?

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4. Where did the sediment settle in the lake? Why?

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5. If the sediment deposit continues, how do you think it will affect the plants and animals? Explain.

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6. Design a plan that would reduce the amount of sediment entering the lake. Explain how your process would work. Draw pictures to illustrate your plan of action.

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Picture:



# Water Pollution

## *How do detergents and fertilizers affect aquatic life?*

**Summary:** This lesson is designed to demonstrate the effects of detergents and fertilizers on aquatic life.

**Duration:** 2 weeks

**Setting:** Lab

**Vocabulary:** pollution, point pollution, nonpoint pollution, eutrophication, cultural eutrophication, algal bloom, leaching

**Standards/Benchmarks Addressed:** SC1-E1, SC1-E2, SC2-E1, SC2-E2, SC3-E1, SC4-E1, SC4-E3, SC4-E4, SC4-E5, SC5-E1, SC5-E2, SC6-E1, SC6-E2, SC6-E3, SC6-E4, SC6-E5, SC6-E6, SC6-E7, SC7-E1, SC7-E2, SC7-E3, SC9-E2, SC11-E3, SC11-E6, SC12-E1, SC12-E2, SC16-E1, SC16-E3

### **Objectives**

Students will:

- examine the effects of detergents and fertilizers on aquatic life.
- test for dissolved oxygen in pond water samples.
- collect and interpret data.

### **Background**

Water pollution is a very serious problem. There are two major sources of pollution. One is point source pollution. This form of pollution enters the waterways from a pipe or some other clear point of discharge. An example is a sewer pipe that empties into a river. The other is nonpoint source pollution. This form of pollution enters waterways from various sources, none of which can be identified. Examples of this type of pollution include: fertilizers, pesticides, detergents, and other chemicals that run off into our local rivers, creeks, ponds, and groundwater. Most of the pollution in the cave pools at Carlsbad Caverns National Park is directly related to nonpoint source pollution. The cave pools have trace amounts of antifreeze, motor oil, and other chemicals that have run off the parking lot and have slowly worked their way to the pools through leaching. Leaching is the process by which materials on or in the soil dissolve and are carried into aquifers by water seeping through the cracks in the rocks.

When nitrate-containing fertilizers and phosphate-containing detergents get into the surface water, they deplete the oxygen supply. These nitrates and phosphates act as fertilizers for algae and can cause them to grow at a tremendous rate; this process is called eutrophication. It is called cultural eutrophication when the introduction of these nutrients is related to human activity with detergents and fertilizers.

A direct result of cultural eutrophication is a rapid increase in algae. This is referred to as algal bloom. The increase in algae causes the water to become cloudy and it decreases the amount of oxygen in the water. Some types of algae release toxic substances into the water. These toxins can then be ingested by the aquatic life and enter the food chain. Humans can get food poisoning from eating these organisms. All aquatic organisms need a supply of oxygen to survive. With algal blooms and the decreased amount of oxygen available organisms will begin to die.

In the summer of 2002, there was a mysterious fish death incident in the Pecos River near Carlsbad, New Mexico. The New Mexico Game and Fish Department was called in to investigate the reasons for the fish dying along the river. The final conclusion was that an algal bloom had depleted the oxygen in the water causing the fish to die.

### Materials

Dissolved Oxygen Test kit  
10 jars  
Trowel  
Water, plants, and mud from a pond  
Detergent containing phosphates  
Fertilizer in powder form  
Measuring spoons  
Data Sheet  
Graph paper  
Journal

### Procedure

**Warm up:** Discuss with students the ways phosphates and nitrates make their way into rivers, lakes, and ponds. Explain to them that this lab will allow them to see the effects of these pollutants in our waterways.

### Activity

1. Divide the class into groups of 2.
2. Have each group use the dissolved oxygen test kit to measure the amount of dissolved oxygen in the pond water. Write the amount on their data sheet.
3. Label the jars 1-10. Cover the bottom of each jar with mud and plants. Then fill each jar with pond water.
4. Place the appropriate amount of fertilizer or detergent in each jar using the amounts in the chart below.

Jar	Treatments
1	Control – no treatment
2	Control – no treatment
3	1/8 tsp. Detergent
4	1/4 tsp. Detergent
5	3/8 tsp. Detergent
6	1 tsp. Detergent
7	1/8 tsp. Fertilizer
8	1/4 tsp. Fertilizer
9	3/8 tsp. Fertilizer
10	1 tsp. Fertilizer

5. Place all the jars in sunny place.
6. Make observations daily for two weeks. Write observations in journals. What do you see happening? What changes have you noticed in each of the jars?
7. Measure the amount of dissolved oxygen each week (preferably on days 7 and 14). Write your amounts on the data sheet.
8. Discuss the students' observations and draw conclusions.
9. Graph the results of the dissolved oxygen test.

**Wrap Up:** Discuss the students' observations and draw conclusions. Graph the results of the dissolved oxygen test.

### **Assessment**

Data sheets, journal summaries, graphs

### **Extensions**

- Discuss the possible sources of nitrogen and phosphates.
- Have students list the things they can do to stop pollution.
- Have student perform the same experiment, however this time using a combination of the two pollutants.
- Ask a water quality expert from the city or National Park to come in and discuss the process of cleaning up polluted water.
- Ask the Game and Fish Department to come in and discuss the effects of algal bloom on the fish population and its connection to pollution in the waterways.

\*For: Dissolved Oxygen Test Kits:  
Carolina Biological Supply Co.  
2700 York Road  
Burlington, NC 27215  
1-800-334-5551

# Water Pollution Data Sheet

Name: \_\_\_\_\_

Jar	Treatment	Dissolved Oxygen Before Treatment	Dissolved Oxygen Day 7	Dissolved Oxygen Day 14
1	Control – no treatment			
2	Control – no treatment			
3	1/8 tsp. Detergent			
4	1/4 tsp. Detergent			
5	3/8 tsp. Detergent			
6	1 tsp. Detergent			
7	1/8 tsp. Fertilizer			
8	1/4 tsp. Fertilizer			
9	3/8 tsp. Fertilizer			
10	1 tsp. Fertilizer			

Use the information from the chart above to graph the effects of detergents and fertilizers on the oxygen content of water. You will need to use your own graph paper for the graphs.